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Benthic-pelagic coupling in Pliocene ocean: Geochemical and micropaleontologic evidence in the ichnofossil Phymatoderma

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Numerous studies have revealed the evidence of benthic-pelagic coupling in various ocean areas. In terms of marine benthos, it is well known that feeding, growth and reproduction are generally synchronized with the seasonal input of phytodetritus to the sea-floor. However, compared to examples of modern organisms, little is known about the evidence of the ancient benthic-pelagic coupling. Thus, the present study carried out the geochemical and microscopic analyses of the fecal pellet-filled ichnofossil *Phymatoderma* from the Pliocene deep-sea strata. The aim of this study is to assess whether benthic-pelagic coupling functioned in the ancient ocean, with special attention to the temporal relationship between phytodetritus input and deposit feeding by the trace-maker. Elemental analysis revealed that Ca, which is probably derived from the calcareous microfossils, is significantly accumulated in the tuffaceous pellets. Because the CaO content of the pelletal infill are generally similar to that of the host siltstones, it may be concluded that the recognized Ca accumulation in pellets does not reflect diagenetic alteration. SEM observations showed the presence of various types of microfossils (i.e., coccoliths, diatoms, planktonic foraminifera, radiolaria) within the pelletal infill of *Phymatoderma*. In addition, excreted tuffaceous fecal pellets are occasionally found to be composed exclusively of coccoliths. Considering all these lines of evidence, it is most likely that the deposit-feeding by the *Phymatoderma*-producer was synchronized with an episodic (probably seasonal) coccolithophore bloom deposition on the deep-sea floor. The reconstructed feeding strategy may have facilitated the effective uptake of freshly deposited phytodetritus. This interpretation is quite reasonable because such a mode of feeding has been commonly recognized in the case of deep-sea deposit-feeding macro and megabenthos. In summary, this study provides geologic evidence for benthic-pelagic coupling in the Pliocene ocean.